

Clinical and Angiographic Results of Intra-Aneurysmal Embolization for Cerebral Aneurysms and Histopathological Findings in an Aneurysm Treated with GDC

Y. KAKU, S. YOSHIMURA, J. KOKUZAWA, N. SAKAI

Department of Neurosurgery, Gifu University School of Medicine; Japan

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Summary

We describe follow-up clinical and angiographic results in patients with cerebral aneurysms treated with IDC or GDC. In 175 patients, 116 patients with ruptured aneurysm and 59 patients with non-ruptured aneurysm who underwent endovascular occlusion of aneurysms, there was no mortality and nine cases (4.7%) with morbidity in the periprocedural period. During follow up period, four cases (2.3%) experienced bleeding, and three cases (1.7%) experienced thrombo-embolic events. On the follow-up angiograms (median angiographic follow-up period 24.8 months), 12.5% of incompletely obliterated aneurysms exhibited progressive thrombosis, 20% remained unchanged and 67.5% showed aneurysmal recanalization or regrowth. Histological examination of a small ruptured A-com aneurysm treated seven months before harvesting, demonstrated that formation of an incomplete endothelium-lined layer of connective tissue at the orifice, and no complete fibrous obliteration of the aneurysm lumen could be detected, various amounts of unorganized clot were still present in the center of the aneurysm.

Coil embolization is a safe treatment for cerebral aneurysms with a lower incidence of peri-

procedural morbidity, whereas follow-up results are less satisfactory in cases involving incompletely obliterated lesions.

Introduction

Endovascular embolization using GDCs or IDCs for complicated intracranial aneurysms has become widely accepted as an alternative to direct surgery^{2,3,6,8}. Although short and midterm follow-up studies report excellent clinical results when using GDCs in the treatment of cerebral aneurysms, data concerning the long term clinical and angiographic results of this technique are still pending.

In this study, we describe the long-term follow-up clinical and angiographic results in patients with cerebral aneurysms treated with IDC or GDC, and histopathological findings of a small ruptured cerebral aneurysm treated seven months before harvesting.

Case Report

175 patients with cerebral aneurysms underwent detachable platinum coil embolization between april 1994 and april 2001; 116 patients with ruptured aneurysm and 59 patients with non-ruptured aneurysm. In 175 patients who

underwent detachable platinum coil embolization (43 males and 132 females with the ages ranging from 15 to 86 years - mean 63.2 years), 114 aneurysms were located in the anterior circulation and 61 in the posterior circulation. 63 aneurysms were small in size (< 10 mm) with a well defined neck, 66 were small sized with an ill-defined neck, 33 were large (10-25 mm) and 13 were giant (> 25 mm).

Postembolization follow-up cerebral angiograms were obtained within six months and repeated annually if a complete obliteration was not confirmed.

Results

Initial clinical results:

166 patients (95.3%) were neurologically intact or remained clinically unchanged. There were nine (4.7%) permanent neurological deficits following the procedure. Intra-procedural perforation of the aneurysm occurred in four patients (2.2%).

Follow-up clinical results:

During the follow-up period ranged from six to 87 months with mean follow-up period of 24.8 months, four cases (2.3%) had delayed bleeding and consequently died, and three cases (1.7%) of thrombo-embolic events; one minor stroke in the same vascular territory of the previously embolized aneurysm (seven months after procedure), two transient ischemic attacks. In one patient with MCA aneurysm, a follow-up CT scan obtained 18 months after the procedure, showed a marked brain edema adjacent to the aneurysm, and direct surgical clipping and aneurysmectomy resulted in rapid amelioration of surrounding brain oedema.

Follow-up angiographic results:

One aneurysmal recanalization was observed in 18 completely obliterated aneurysms. In 40 aneurysms with neck remnant and/or body filling, 12.5% of incompletely obliterated aneurysms exhibited progressive thrombosis, 20% remained unchanged and 67.5% displayed recanalization or regrowth on follow-up angiography (figure 1).

Representative Case Report and Histopathological Findings

A 57-year-old woman had a subarachnoid haemorrhage, and her neurological grade was WFNS grade 4. A Cerebral angiography re-

vealed a small A-com aneurysm with ill-defined neck (figure 2A). As admission chest X-ray demonstrated pulmonary oedema, direct surgery was thought to be unsuitable. Endovascular occlusion with GDC was performed 12 hours after onset. Post-embolization angiogram demonstrated complete obliteration of the aneurysm (figure 2B). Her neurological condition improved over the following days. She showed no neurological deficits at discharge on day 21. A follow-up angiogram obtained six months after the endovascular occlusion of the aneurysm demonstrated recanalization of the aneurysm in its proximal portion (figure 2C). Direct surgical clipping and aneurysmectomy was performed (figure 3A-C).

Gross examination of the resected aneurysm showed the coils to be embedded in and covered by a white, fibrous membrane (figure 3D). Histological examination demonstrated that incomplete formation of an endothelium-lined layer of connective tissue at the orifice, and no complete fibrous obliteration of the aneurysm lumen could be detected, various amounts of unorganized clot were still present in the center of the aneurysm. An organized thrombus with capillaries, fibrous connective tissue, and infiltrating inflammatory cells existed at the margin of the aneurysmal lumen. There was a varied degree of organization of the clot with capillary penetration, the presence of macrophages and other inflammatory cells. The intraluminal thrombus in the immediate vicinity of the coil and between the coil was poorly organized without fibrous tissue formation (figure 4).

Discussion

Endovascular embolization using GDCs or IDCs for complicated intracranial aneurysms has become widely accepted as an alternative to direct surgery. Published reports of early clinical and angiographic results have been promising^{2,3,8}, but the long-term efficacy of the GDC or IDC methods has yet to be determined. Incomplete endovascular occlusion of the aneurysm leaves the patient at risk for future expansion and future subarachnoid haemorrhage^{5-7,9}. Hayakawa et Al evaluated the anatomical evolution of neck remnants in aneurysms treated with GDCs. They reported that 25% of aneurysms with neck remnant exhibited progressive thrombosis, 26% remained unchanged and 49% displayed recanalization

long term angiographic follow up results

incomplete occlusion 40 cases

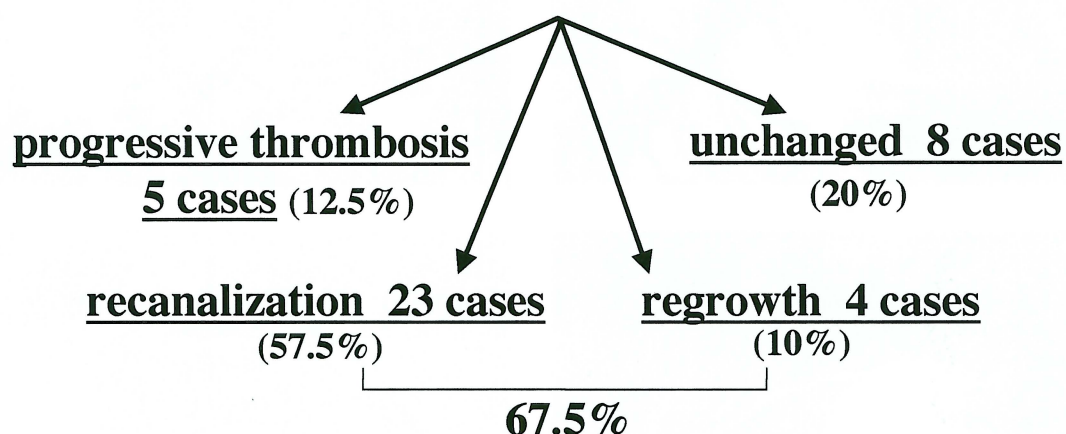


Figure 1 Long term angiographic follow-up results of 40 cases with incompletely embolized aneurysm.

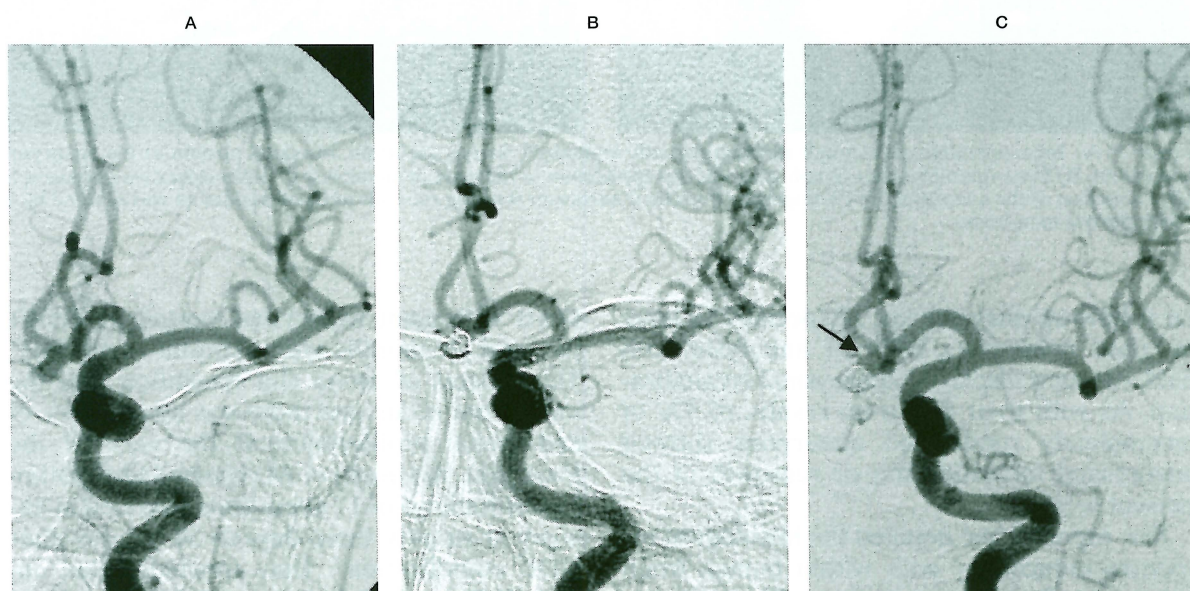


Figure 2 A) Left internal carotid angiogram showing small A-com aneurysm with ill-defined neck. B) Left internal carotid angiogram obtained immediately after GDC embolization, demonstrating complete aneurysmal occlusion. C) Left internal carotid angiogram obtained 6 months after GDC embolization, demonstrating aneurysmal recanalization in its proximal portion (arrow).

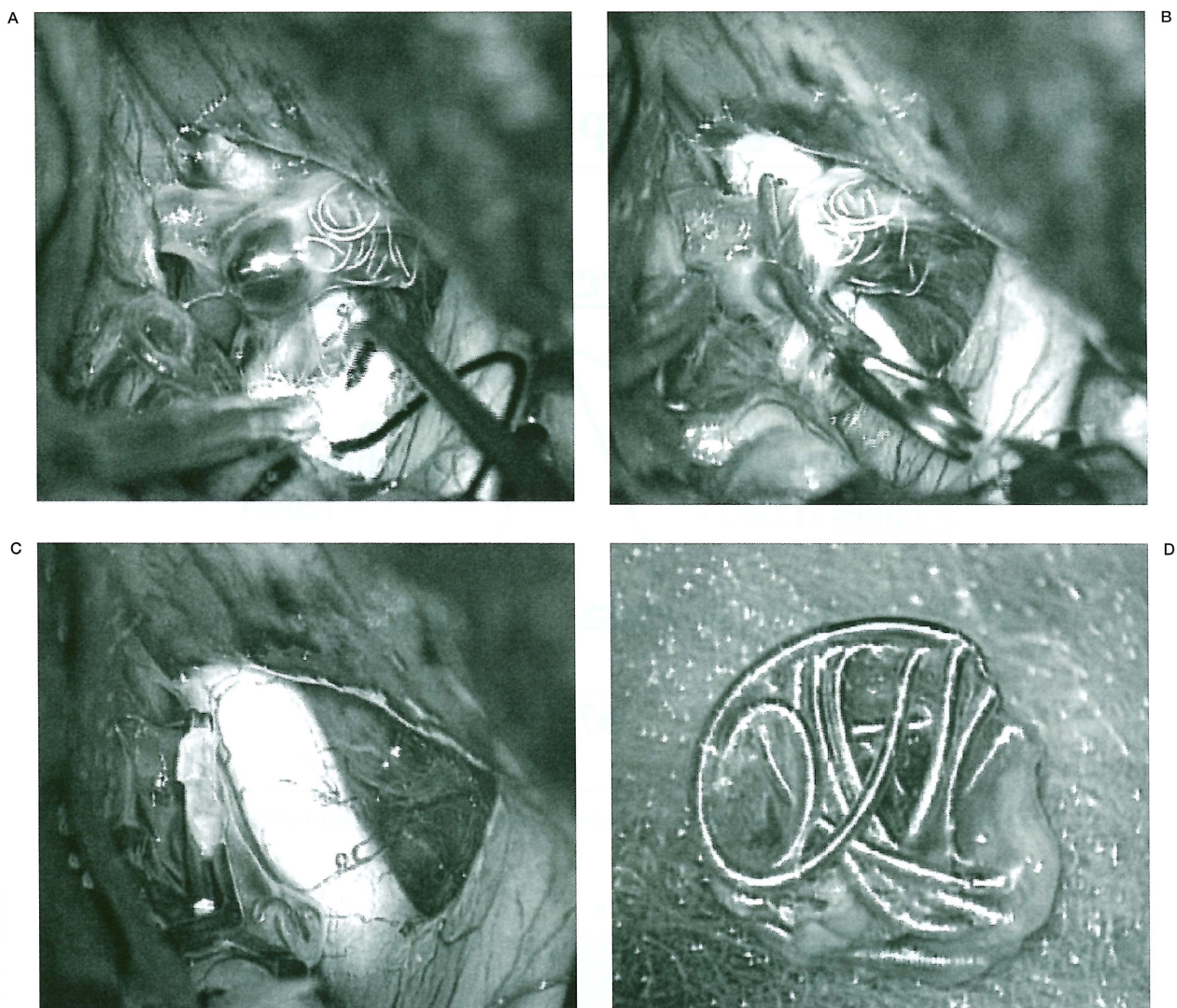


Figure 3 A) Intra-operative photograph showing partially embolized A-com aneurysm. Proximal portion of the aneurysm was patent. B) Intra-operative photograph after the clip application to the neck of aneurysm. C) Intra-operative photograph after resection of the aneurysm. D) Photograph of resected aneurysm showing the coils to be embedded in and covered by a white, fibrous membrane.

on follow-up angiography⁴. Especially in large or giant aneurysms, 88% of aneurysm with neck remnant displayed aneurysmal recanalization. As with their follow-up results, 67.5% of incompletely obliterated aneurysms showed aneurysmal recanalization or regrowth in the present series.

Few reports have detailed the histological responses induced by coils within human brain aneurysms. In contrast to favorable tissue responses in experimental models, clinical findings demonstrated less satisfactory results. Molineux et al reported autopsy studies of two pa-

tients with giant aneurysms treated by GDCs two and six months after subtotal occlusion¹⁰. The process of blood clot resolution into the sac did not occur, and there was no evidence of endothelial proliferation at the neck of the aneurysm. Bavinski et al reported histopathological findings of 17 aneurysms obtained at autopsy or surgery three days to 54 months after GDC embolization¹. They concluded that endothelialization of the aneurysm orifice following GDC embolization can occur, but it appears to be the exception rather than the rule. In large aneurysms, the process of intramural

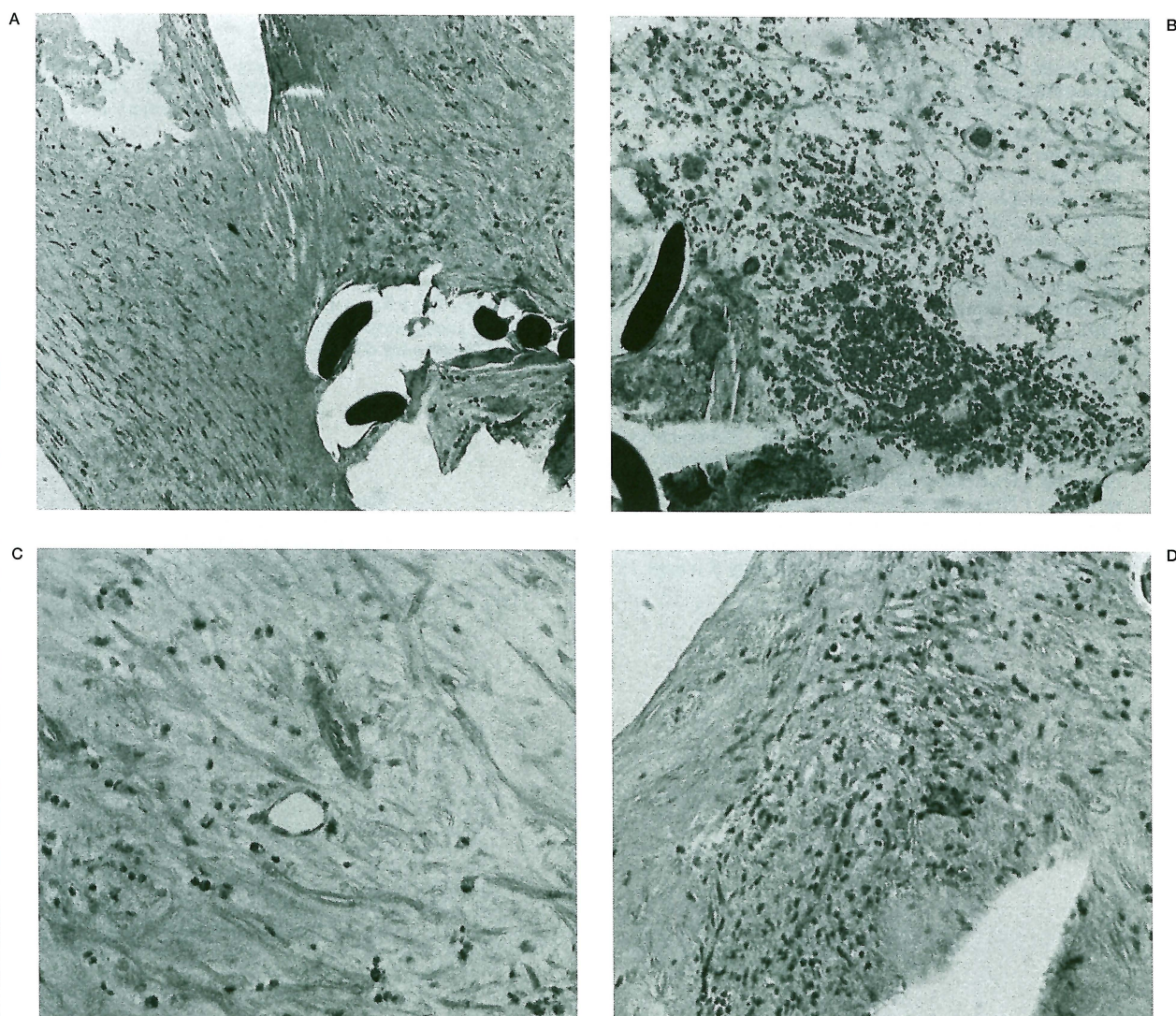


Figure 4 Photomicrographs of histological section. A) Formation of an endothelium-lined layer of connective tissue at the orifice. B) Various amounts of unorganized clot in the immediate vicinity of the coil and between the coils. C) Various degrees of organization of the clot with capillary penetration in the periphery of the aneurysm. D) Fibrous connective tissue, and infiltrating inflammatory cells at the margin of the aneurysmal lumen.

clot organization seems to be delayed and incomplete, tiny open spaces between the coils and an incomplete membranous covering in the region of the neck are frequently encountered. It is important to recognize that even small densely packed aneurysms, those considered 100% occluded on angiography, may recanalize over the years because of persisting tiny open spaces between the coils at the neck region, as was observed in the present histological study. These findings emphasize the need for long term clinical and angiographic follow-up to assess the long-term efficacy of this treat-

ment in the management of patients with cerebral aneurysms.

Conclusions

Coil embolization is a safe treatment for cerebral aneurysms with a lower incidence of peri-procedural morbidity, whereas follow-up results are less satisfactory in cases involving incompletely obliterated lesions. With this limitation in mind, patients need to be very carefully chosen for GDC embolization and strict follow-up angiography is mandatory.

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Yasuhiko Kaku, M.D.
Department of Neurosurgery
Gifu University School of Medicine
40 Tsukasamachi, Gifu 500-8705, Japan
E-mail: kaku@cc.gifu-u.ac.jp